Intelligent Automation Incorporated

Coherent distributed radar for high-resolution through-wall imaging

Progress Report 23

Contract No. N00014-10-C-0277

Sponsored by

Office of Naval Research
COTR/TPOC: Martin Kruger

Prepared by
Eric van Doorn, Ph.D. (PI)
Satya Ponnaluri, Ph.D.

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE **FEB 2012**	2. REPORT TYPE	3. DATES COVERED **00-00-2012 to 00-00-2012**

4. TITLE AND SUBTITLE **Coherent Distributed Radar For High-Resolution Through-Wall Imaging**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Intelligent Automation Incorporated,15400 Calhoun Drive, Suite 400,Rockville,MD,20855**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S) 11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**4**	

1 Work performed this reporting period

1.1 Technical work performed in this reporting period

In this reporting period, we are continuing to collect indoors data and processing the scans for improving the indoors range accuracy. Since the transceivers are very tightly synchronized, the transmission phase and time, and the phase use for down conversion are well-controlled and repeatable as we perform the experiments.

We are continuing to take more data and develop algorithms for improved range accuracy based on both channel estimation and digital beamforming.

To facilitate the collection of data, we have configured the hardware and software to stream the complex correlator output at a rate of 10Hz to the PC. This will allow us to evaluate several algorithms for RF ranging offline.

A key parameter for the beam forming algorithms that will be used to improve ranging accuracy (and for imaging) is the aperture: the spatial range over which the multipath environment is sufficiently stationary to be processed coherently. If this aperture is large, a narrow beam can be formed, and multipath can be suppressed effectively. One way to estimate this parameter is to compute the spatial correlation length of the range error. In Figure 1, below, we show the results of an outdoor ranging experiment.

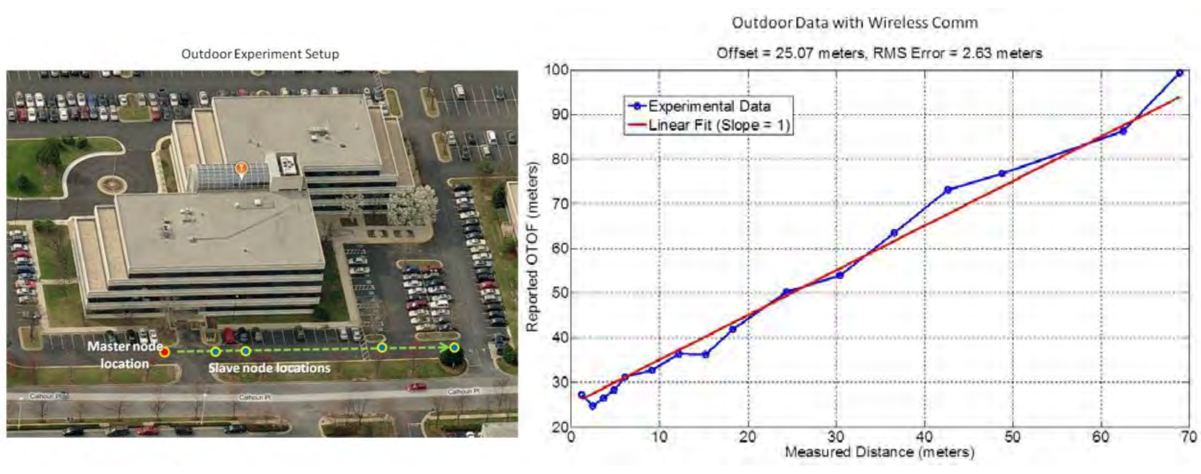

Figure 1. Left: outdoor ranging experiment. Right: reported distance vs. actual distance.

In Figure 2, we show the range error vs. range, and the spatial autocorrelation of the error. The range error de-correlates in about 10m.

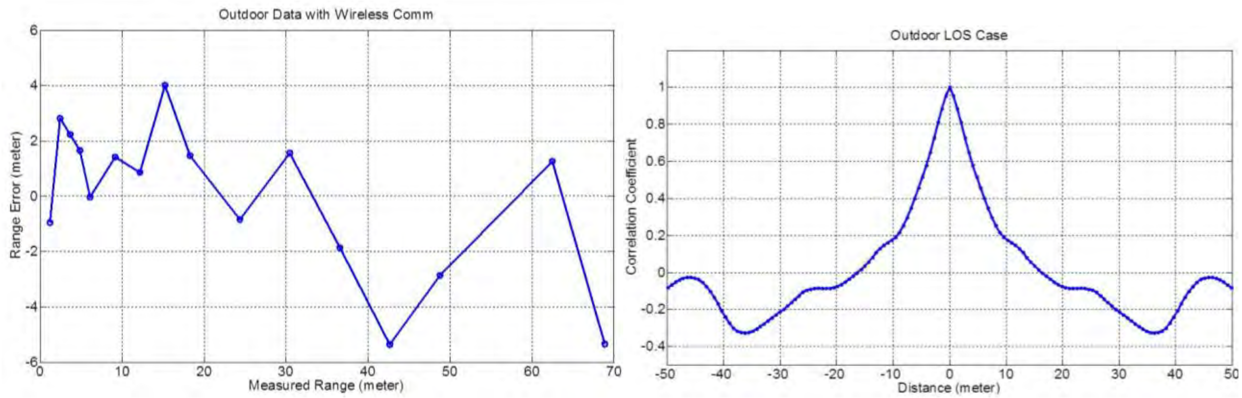

Figure 2. Left: Range error vs. range. Right: Spatial autocorrelation of range measurement.

This result is specific to the particular outdoor environment; carrier, bandwidth, and ranging algorithm used here, but suggest that an aperture of several wavelengths is possible. With beamforming measurements spaced at roughly half wavelength, the potential for beam forming is present.

For an indoors environment, due to the higher density of scatters, the error de-correlates faster, and hence the aperture will be smaller, reducing the potential for beam forming to improve the range accuracy. We show the autocorrelation plots for an indoor office environment below.

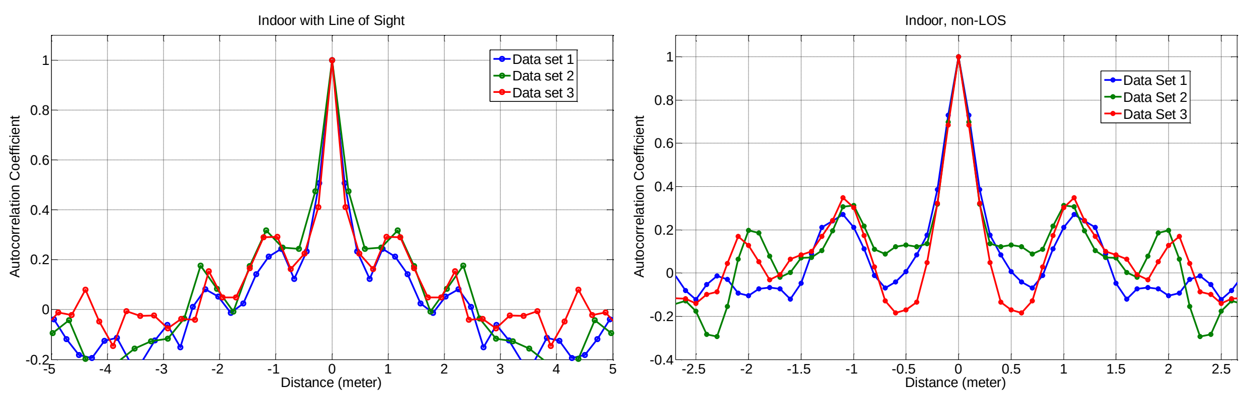

Figure 3. Autocorrelation of range measurement. Left: indoor environment with LOS (corridor). Right: indoor environment without LOS.

For the indoor environment, the aperture will be reduced to 1-2m, essentially making the beamforming approach, at the used frequencies and bandwidth, not suitable for the indoor environment.

In the next performance period, we will continue to take measurements, and develop ranging algorithms, as well as imaging algorithms for bi-static radar.